

Measurement of Saturated Liquid Densities by a New Apparatus with a Buoyancy Method

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A new apparatus was constructed to measure vapor-liquid equilibria of pure and mixed fluids together with the density in the saturated liquid phase. The density measurement is based on the buoyancy method using the single-sinker method and a magnetic suspension balance [1]. A single sinker is placed inside the measuring cell. The liquid level inside the cell is measured by three small platinum resistance thermometers to ensure that the single sinker and the permanent magnet which carries the sinker are completely emerged in the liquid phase. The vapor phase is placed coaxially around the electromagnet which is separated from the fluid by the stainless steel cell walls and transfers the buoyancy forces of the sinker through the walls to a microbalance. The suspension balance, liquid level indicator, and measuring cell were purchased from RUBOTHERM company [2]. The measuring cell was modified to enable sampling from both phases in case of mixed fluids. It has an internal volume of about 200 ml with about 30% occupied by the vapor phase. The single-sinker apparatus is limited to temperatures within -60 and 250°C, pressures up to 250 MPa, and densities within 10 and 2000 kg/m³. First tests were done with pure fluids for temperatures within -60 and 100°C and for pressures up to 6.7 MPa to show the accuracy of the density, temperature and pressure measurements. Water was used to test the measurement of compressed liquid densities, nitrogen for supercritical gas densities, and carbon dioxide and some refrigerants for saturated liquid densities. Comparison of the experimental data with accurate reference equations will be shown. Accuracies are within 0.02 K for the temperature, 0.001 MPa for the pressure, and 0.03% 0.01kg/m³ for the density.

[1] W. Wagner, K. Brachthäuser, R. Kleinrahm, and H.W. Lösch Int. J. Thermophys. 16:399 (1995).

[2] RUBOTHERM Präzisionsmesstechnik GmbH Universitätsstrasse 142, D-44799 Bochum, Germany.